RECLAMATION
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Uinta Basin Replacement Project High Lakes Stabilization Technical Memorandum

Swift Creek Drainage
Deer Lake and East Timothy Lake

U.S. Department of the Interior
Bureau of Reclamation
Provo Area Office
Provo, Utah

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prepared by

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Introduction

The Uinta Basin Replacement Project (UBRP Project) was authorized by Section 203 of the Central Utah Project Completion Act [CUPCA: Titles II through VI of P.L. 102-575, as amended]. The UBRP Project is located in Duchesne County near the towns of Altamont, Upalco, and Roosevelt, within the Uinta Basin of northeastern Utah. Its purposes are to increase efficiency, enhance beneficial uses, and achieve greater water conservation within the Uinta Basin. The Central Utah Water Conservancy District (District) is implementing the water development portions of the UBRP Project, and the Utah Reclamation Mitigation and Conservation Commission (Mitigation Commission) is responsible for mitigating project impacts to fish, wildlife and wetland habitats. Funding for mitigation measures is provided under Title II of CUPCA through the U.S. Department of the Interior. The Final Environmental Assessment for the UBRP Project was prepared by the District and was signed by the Department of the Interior in October 2001. Project construction began in 2003. The Commission issued a Decision Notice and Finding of No Significant Impact in February 2004 for implementing fish and wildlife mitigation features of the UBRP Project. The stabilization project is one of those requirements.

A component of the UBRP Project is that thirteen high mountain lakes formerly used to store water rights would be stabilized at No-Hazard levels, and the water rights transferred downstream for storage in the enlarged Big Sand Wash Reservoir, another feature of the UBRP Project. The stabilization of the thirteen reservoirs is mitigation for the enlargement of Big Sand Wash Reservoir. Because of the breach potential of the High Lakes Dams, and the difficulty in monitoring and maintaining these dams in the Wilderness area, the Mitigation Commission is undertaking the stabilization of thirteen of these dam structures. The storage water rights will be transferred downstream in the expanded Big Sand Wash Reservoir where maintenance and monitoring is practical. These wilderness dams vary in size, hazard rating and condition and have peak breach flow potential ranging from hundreds to several thousand cubic feet per second (cfs). Breach flows of this magnitude far exceed the carrying capacity of existing streams and they would cause extensive damage to the downstream forest resource, campgrounds, trails, roads, dams and in some cases, private property and residents. The “do nothing” option was not considered appropriate because of the eventuality of the deterioration and potential for catastrophic failure of these dams.

There are no absolute criteria for defining a No-Hazard dam. The Utah State Engineer is authorized to make that determination. Section R655-10-5 of The State of Utah Statutes and Administrative Rules for Dam Safety dated July 1996 states “The State Engineer is the ultimate authority on the hazard classification designation for a given dam.” The Forest Service also has dam safety responsibilities and the two agencies have outlined a number of protocols regarding dam safety matters in a memorandum of understanding between the two agencies (attached as Appendix A). Therefore, all decisions and recommendations regarding these structures are mutually agreed on by both parties.

Essentially, the No-Hazard rating is achieved by demonstrating that in the event of failure, there is no appreciable damage or adverse affects downstream of the dam. For the more significant structures, this demonstration is accomplished through a dam break analysis. Various stabilized reservoir elevations are assumed and the resulting flood from a sunny day break is compared to the existing downstream channel capacity. When the analyses show that a stabilized reservoir elevation would result in a flood that can be contained within the downstream channel, the dam can be considered to be No-Hazard. A guidance design criterion from the State of Utah is that the dam break should produce a maximum flow of less than 500 cubic feet per second (cfs).

Stabilization of the thirteen high mountain lakes at No-Hazard levels will provide constant lake water levels year-round. Nine of the lakes (Bluebell, Drift, Five Point, Superior, Water Lily, Farmers, East Timothy, White Miller, and Deer) are located in the Upper Yellowstone River watershed and four (Brown Duck, Island, Kidney and Clements) are in the Brown Duck Basin of upper Lake Fork watershed. Consequently, streamflows originating in these upper watersheds will return to natural hydrologic runoff patterns, wilderness fishery and recreational values will be restored within the High Uintas Wilderness Area (HUWA), and operation and maintenance impacts will be eliminated in the HUWA.

The U.S. Forest Service, Moon Lake Water Users Association, U.S. Bureau of Reclamation and Duchesne County Water Conservancy District all have knowledge and experience with operation, maintenance and stabilization of the high mountain lakes. The Commission entered into Interagency Agreement No. 05-AA-UT-1300 with Reclamation to provide engineering, design, construction, and oversight services for the stabilization project. This technical memorandum is a work product under the Interagency Agreement and addresses design criteria needed to achieve a “No Hazard” rating as defined by the State of Utah and as agreed to by the Forest Service, for Deer Lake and East Timothy Lake in the Swift Creek Basin.

White Miller, Water Lily, and Farmers Lakes were stabilized in 2006. Clements Lake was stabilized in 2007. Brown Duck and Island Lakes were stabilized in 2008. Kidney Lake in the Brown Duck Basin was stabilized in 2009, as were all four lakes (Superior, Five Point, Drift and Bluebell) in the Garfield Basin. The stated objective for these lakes is to create conditions such that any dam, if remaining, is assigned a “No Hazard” classification with a minimum design life of 100 years (essentially a permanent fix).

Typically, the stabilization of these dams will require the excavation of a spillway notch, with stable side slopes, through the middle of the embankment and either removal or plugging of the existing low level outlet. An armored, stabilized low level channel would then be constructed in the notch to pass normal runoff as well as large storm events without jeopardizing the remaining structure by impounding excess water. In some cases the embankment may be removed or buttressed to decrease the height and increase the stability and ability of the remaining embankment to withstand any seismic event or overtopping during extreme events. This work is the minimum necessary to stabilize these dam structures and restore natural hydrologic flows to the greatest extent possible, while still meeting a "No Hazard" dam safety rating.

An additional constraint is that each dam stabilization project needs to be completed in one construction season (usually July through September) because of the vulnerability of a partially removed embankment. A partially completed dam could easily overtop and fail from snow melt runoff or storms, even if the outlet were still in place and open. Breach flow potential would be extensive even from the reduced lake storage volumes. Existing spillways would be too high to assist in flood routing under these circumstances and it would be prohibitive to build auxiliary or temporary spillways over the excavated embankment or on bedrock at the proper level, even if it could be located (see Appendix A).

Multi-year construction projects to stabilize a single dam have serious potential problems, including:

- Increased vulnerability to failure from hydraulic overloading when partial breaches may not be adequately stabilized;
- High potential for erosion and soil disruption from over-wintering and unexpected weather events;
- Additional required work and disturbance to reconstruct and stabilize the dam at the end of each construction season;
- Increased mobilization and demobilization costs from additional work cycles;
- Increased site disturbance from multi-year operations at camps, travel routes, and activity on-site;
- The U.S. Forest Service does not allow riprap spillways on moderate-hazard earth fill dams; therefore any intermediate “spillway” or outlet channel on a partially stabilized dam would be required to be hardened, probably with concrete; and
- High potential for unexpected, early adverse weather conditions which could close the construction project prior to adequate stabilization.

In addition, because these dams were constructed at the turn of the century there is no guarantee that plans are accurate. Once breached, there may be unexpected materials or inappropriate materials in the dam that would not support a partial breach option. A partial breach may also create unanticipated new flow regimes.

Other considerations with multi-year projects include:

- Uncertainty of weather from year to year which may require additional measures to ensure partially breached dams are secure;
- Longer exposure of crews to accident vectors during the multi-seasons;
- Increased risk of personnel changes leading to loss of skills and experience; and
- Loss of availability of equipment.

Based on past experience, success with multi-year staged construction projects has been low.

The Forest Service does not recommend planning for a multi-year project to stabilize an individual dam. Further, they have advised that at the completion of each season of activity the partially-stabilized dam will be required to fully meet State of Utah and U.S. Forest Service dam safety specifications. Due to the existing condition of many of the dams, achieving this requirement could entail even more extensive work and could be more difficult to achieve than completing the stabilization to its final proposed configuration.

It was determined that this risk possibility was inconsistent with the projects goals of safety and stabilization as well as minimum impact and the preservation of the Wilderness resources and values.

As indicated by the concurrence page, the purposes of this memorandum are to document the design decisions and rationale used in the final designs and to ensure each of the participating agencies are in agreement with and approve of the final designs. This memorandum describes the design of the proposed stabilized dams on Deer Lake and East Timothy Lake in the Swift Creek Basin.

Many of the design considerations and much of the logic and approach to this project is applicable for each of the dams. As such, the narratives described for Deer Lake are not fully repeated for East Timothy Lake, unless there are differences. Although there is some repetition, it is avoided to the extent possible to maintain a readable report.

The appendices contain design drawings and backup data that support the design conclusions and recommendations. Appendix A contains a copy of the MOU between the State of Utah and U.S. Forest Service for dam safety. Appendix B contains design drawings showing a location map and applicable details for each lake. Appendix C contains portions of the HEC-1 output files for the inflow hydrology. The total output file for this work contains numerous pages, most of which is hydrograph data not necessarily meaningful to most readers. Rather than include the entire output, a select page containing relevant flow data is provided. The remaining output will be kept on file and made available upon request. Table 1 (below) contains a brief summary of storm hydraulics. Appendix D contains a summary table of construction quantities for the designed work. Appendix E contains a summary of the Simplified Dam Break analyses. The total output file for the dam break analysis also contains additional pages kept on file and available upon request. Appendix F contains historical drawings of the dams and associated features. Appendix G contains a summary for the slope stability analysis and the surface sample gradations taken from East Timothy Dam.

Another item of note concerns the apparent elevation discrepancies between the various data sets. Each dam was topographically surveyed using global positioning satellite (GPS) equipment. The elevations measured and used for the drawings are actual elevations tied to the State Plane Coordinate System. However, the Digital Elevation Models (DEM) used for the hydrology and dam break analyses were obtained from the U.S. Geologic Survey (USGS) data base which does not match the State Plane elevations. Because of these differences, model adjustments were made accordingly. As long as the relative differences in elevation are accounted for, the data will be accurate and usable. Although some of the elevations for spillway and dam heights in the DEMs do not match the actual elevations as obtained through the surveys, they are still applicable because the relative differences are consistent. Because of these differences, model adjustments were made accordingly. Table 2 (below) summarizes this data.

Table 1. Summary of SCS Type II 6-hour 100-Year Storm Hydraulics

Lake	Surface Area (ac)	Res. Volume (ac ft)	Remaining Embankment Height (ft)	Basin Area (sq mi)	100 yr. Storm (in)	Peak Runoff (cfs)	Max Routed Flow (cfs)
Deer Lake	8.2	22.5	6.7[1]	1.6	2.69	111	73.0
East Timothy Lake	19.5	20.0	9.0	3.5	2.79	320	130

[1] Although the embankment height is listed as 6.7 feet, the effective depth is only 5 feet. There is a small, localized depression at the upstream inlet of the pre-existing dam.

Table 2: Elevation Data used in this Technical Memorandum

Lake	Top of Dam	Stabilized Breach Elevation	"Natural" Lake Elevation	Invert of Existing Outlet Works
Deer Lake	10,230.0	10,218.0	10,216.0	10,211.3
East Timothy Lake	11,040.5	11,012.5	11,012.0	11,003.5

Design Considerations

A number of issues and considerations must be accounted for in the design. These include the following:

- Inflow hydrology
- Dam break analysis
- Outlet works removal or plugging with associated cutoffs and filters
- Outlet channel configuration including width, armoring, and side slope stability
- Downstream connection to existing channel needs to accommodate drop in elevation between outlet channel and original ground. The downstream connection will be arranged in the field.
- All reasonable efforts will be made to blend outlet channel into the natural drainage in the area, to the extent that it does not require a significant increase in resources to do so.

Neither reservoir is currently storing water; the outlets are open. However, it is likely that some surcharging of the basin will occur during June. It is hoped and expected that water surface elevation will return to its minimal level during the early days of th stabilization project effort in 2010.

Deer Lake

Deer Lake is located on an unnamed tributary of Swift Creek. Deer Lake is downstream of Farmers Lake and White Miller Lake, both of which were stabilized in 2006. It has a surface area of about 21 acres at the existing spillway and holds approximately 110 acre-feet of water. The embankment consists mostly of sand and clay with stone riprap facing. The dam is 17 feet high with a 15-foot hydraulic height. The dam has a 24-inch diameter low-level outlet pipe (56 feet long) located at the maximum section.

Inflow Hydrology

The Deer Lake drainage basin is 1.6 square miles in area and is comprised of partially wooded slopes, interspersed with brush and grassy areas. Significant areas of rock and talus slopes are also present on the west side of the lake. The Watershed Modeling System (WMS) software package was used to model the drainage basin using the DEM obtained from the USGS web site. Hydrologic characteristics for the basin were then incorporated for full analysis. The 100-year, 6-hour storm estimate of 2.69 inches was obtained from the National Oceanic and Atmospheric Administration's (NOAA) Precipitation Frequency Data Server, Atlas 14, Volume 1, Version 3. This storm has a peak runoff of 111 cfs. However, when routed through the reservoir, the peak runoff is attenuated to a maximum flow of 73 cfs through the spillway.

The Basin Average method was combined with the U.S. Soil Conservation Service (SCS) Type-II, 6-hour curve to define the series. The SCS curve number method was used to model the basin losses, with a curve number of 66.0 (corresponding to AMC III "fair" conditions). The SCS method was used within WMS to compute a Lag time of 1.01 hours. The Muskingum-Cunge method was used for stream routing with averaged stream characteristics based on actual survey data and/or the DEM. Historical reservoir area-capacity curves were input for routing purposes.

Dam Break Analysis

The Simplified Dam Break (SMPDBK) model contained within the WMS package was used to model multiple runs of dam break scenarios using varying parameters. Various breach elevations were modeled to obtain maximum flows in the downstream channel so that the effects of a dam break could be analyzed and acceptable limits set. The dam break scenario table in Appendix C tabulates the results of various reservoir elevations and the corresponding dam break maximum flow. A guidance design criterion from the State of Utah is that the dam break should produce a maximum flow of less than 500 cfs.

A 15-foot-wide breach was used with a 300 minute time-to-breach. A sunny day break of Deer Lake Dam with the outlet channel at elevation 10,218.0 produces a maximum flow of 78 cfs.

Outlet Works

In order to have a no hazard classification there can be no operable outlet works. The existing outlet works could either be left in place and plugged, or the entire outlet works could be removed. In either case, the existing outlet works gate would be removed. Based on the information available, it is recommended the outlet works pipe be completely removed.

To stabilize Deer Lake Dam, the outlet pipe must be removed. The existing corrugated metal pipe is riddled with holes and could not be sealed adequately using grouting techniques. The outlet pipe will be removed and the trench from which it is pulled will be backfilled and re-compacted.

Breach Channel

Based on the results of the dam break analysis and as shown on the drawings, the maximum recommended breach channel invert elevation is 10,218.0 feet. The breach channel will be built with adequate protection to prevent erosion and down cutting over the top of the trench that will need to be excavated to remove the outlet pipe. A significant challenge is involved in re-compacting the backfill material to a satisfactory density when the outlet pipe is pulled,. The trench will be filled with local material consisting of a matrix of rock and fine soils. The backfill would be compacted as tightly as possible based on the tools allowed to be used. This task will be closely monitored to ensure adequate compaction of the material is achieved.

The re-compacted trench will be buried and submerged near the lake side of the remaining embankment, but will be intercepted by the outlet breach channel towards the downstream side at about Station 00 + 91 (see Profile Drawing in Appendix B for illustration).

The breach elevation will be set at 10,218.0 with a rock sill (unless bedrock is encountered at the designed elevation) at the upstream end of the breach channel. The rock sill will be buried at least 1 foot below the bottom of the riprap. The standard design for the rock sills will include 24” – 36” diameter rocks across the channel. Three or more rock sills will be placed to stabilize the outlet channel. Spaces between and among the rock sills will be filled with local material consisting of a matrix of rock and fine soils. The outlet channel’s excavated side slopes will be flat enough to ensure a good bond between the new compacted backfill and the undisturbed existing ground. This is critical to address to ensure that a seepage path is not created at the interface.

The recommended finished channel width at the invert is 15 feet. Keeping the breach channel a minimum width of 15 feet will help reduce plugging due to ice, snow, and debris. The breach channel will be armored with a 36-inch layer of 18” D_{50} riprap along the invert and for a vertical height of 5 feet on the side slopes. The remainder of the breach channel side slopes will consist of smaller riprap armoring. The armoring of the invert and side slopes will provide protection against erosion and will ensure stable and permanent side slopes. It is critical that the toes of the side slopes do not experience erosion because of slope stability issues. Without toe protection, substantial erosion or undermining of the bottom of the side slopes could result in a complete slope failure resulting in blockage of the channel.

Slope stability on the side slopes of the breach channel was analyzed using SLOPE/W, a limit equilibrium modeling software program. The slopes were required to be flat enough to allow a safety factor of at least 1.5 against failure. Limit equilibrium slope stability solutions are found by segmenting the potential sliding mass into vertical slices and, by static theory, summing the driving and resisting forces of each vertical slice. The safety factor is the ratio of resisting force divided by the driving force. Values less than 1 indicate potential slope instability. The boundary interface between the sliding mass and the base material is assumed to be circular. The failure circle with the lowest safety factor is found through trial and error by exploring a variety of circles whose diameters intersect the embankment. The circle with the lowest safety factor is then utilized for modeling purposes.

Shear strength properties were assumed based on grain-size analyses and plasticity tests performed on samples collected in the field at East Timothy Dam and are representative of soils located within the Swift Creek Basin. The samples were classified according to USCS as Poorly Graded Sand with Silt and Gravel (SP-SM)g. Bowles “Foundation Analysis and Design (1996)” recommends internal friction angle for this type of material to range from 32 to 34 degrees. The embankment materials were assumed to be less dense than the native underlying foundation materials, and consequently assumed to have lower shear strength. The internal friction angles selected for the embankment and foundation materials are 32 and 34, respectively. Additionally, due to the granular nature of the soil, cohesive strength was assumed to be zero.

Another factor that affects the results of the analysis is the assumed level of saturation within the embankment. For normal operating conditions, the saturation level will be less than 1 foot high. However, if the breach channel was to become plugged or there was an extreme inflow event, the saturation level could become somewhat higher. The higher the saturation level, the flatter the side slopes need to be to maintain an adequate safety factor. In order to maintain a conservative design that will be considered to be permanent, a saturation level of 2 feet was used for the stability analysis. Although this level is likely to be higher than what will actually occur, the analysis did not assume any erosion of the toe and therefore should be considered as reasonable. It is possible through a combination of outlet channel plugging and high inflows that the saturation level of the embankment could rise above 1 foot. Therefore, a 2 foot high saturation level is not overly conservative. Additionally, the slope was modeled without riprap. The placement of riprap would increase the factor of safety even further. Based on these assumptions, using a slope of 2.5H:1V, and a breach width of 15 feet, the safety factor against static failure is 1.5. The slope stability analysis is presented in Appendix G.

Because the main criteria for sizing the breach channel width is to prevent snow, ice and debris from building up and blocking or plugging the channel, the recommended width of the channel is much greater than necessary to pass normal breach channel outflows. Therefore, a low flow channel that will generally contain all outflows is incorporated into the design, if possible unless on bedrock.

The breach channel elevation was set to match the new stabilized lake level at the upstream end and to tie into the existing outlet channel on the downstream to provide as smooth and even of a transition as possible. However, in the case of Deer Lake, this will result in a channel slope of about 10 percent. This is more than is normally preferred because in order to keep channel velocities to less than 5 or 6 feet per second for fish passage, the maximum grade within the outlet channel would usually be limited to approximately 5 percent. However, fish passage is not a requirement at this site because the natural drainage blocks connectivity of the lake outlet to the downstream section of the creek through natural barriers. The breach channel will be designed and constructed in a cascading step-pool fashion.

In order to prevent erosion at the toe of the breach channel slopes, channel velocities need to be minimized. In some cases, this will require additional riprap armoring at the downstream end of the new breach channel and existing outlet works channel transition due to several feet of drop required. Field crews will take care to minimize this drop by lengthening the downstream transition as much as possible.

The Storm Spillway Hydraulics table in Appendix C provides 100 year storm hydraulic data for the breach channel flows for Deer Lake dam.

East Timothy Lake

Many of the design considerations and much of the logic and approach to this project is applicable for each of the dams. As such, the narratives described for Deer Lake are not fully repeated for East Timothy Lake. However, there are a few additional considerations that apply to the East Timothy Dam site, and they are discussed in detail below.

East Timothy Lake is located near the top of the Swift Creek drainage basin. The dam is a very large structure for the High Mountain Lakes. It was rebuilt using large equipment in the 1950s. It has a surface area of about 44 acres at the existing spillway and holds approximately 596 acre-feet of water. The dam is more than a quarter-mile long with a crest width of 15 feet and is oriented such that it impounds runoff from two Swift Creek sub-basins.

The structure consists of two embankments and a substantial portion of the dam is actually a naturally-occurring terminal moraine. Topography from original drawings indicates the western portion of the dam is constructed on top of the moraine. This moraine was cut into on the downstream side during the rebuilding of the dam in the 1950s. The eastern portion of the dam was constructed from borrow material taken from a portion of the terminal moraine directly south and east of the western dam. The result of this configuration, in conjunction with inherent geologic properties of moraine material, is a large volume of seepage losses through the moraine portion of the dam. As storage is increased behind the dam, seepage volumes also increase. These seepage flows have contributed to concerns of embankment stability and acceptable stabilization elevations.

The maximum dam height is 37 feet with a hydraulic height of 31 feet. The upstream embankment has stone riprap facing. The dam has an 18-inch diameter low-level outlet pipe, 230 feet in length. There is a short length of cone-shaped pipe on the upstream end of the inlet pipe, which tapers from 24” diameter down to 18”. There is a concrete-walled vertical shaft located on top of the dam; it extends from the top of the dam, down through the embankment to the outlet pipe.

It should be noted that many of the rocks placed as riprap material on East Timothy Dam are in excess of 3 feet in diameter. In order to be able to move the large rock, drilling/blasting or some other method to be determined through the Minimum Requirements Analysis process, will be required to break the rock into smaller pieces. This is also needed in order to develop the appropriate sizes of rock that are needed for the riprap armoring of the breach channel to be constructed.

Inflow Hydrology

The East Timothy Lake drainage basin is 3.5 square miles in area and is comprised of partially wooded slopes, interspersed with brush and grassy areas. Significant areas of rock and talus slopes are also present in the drainage basin. The SCS curve number method was used to model the basin losses, with a curve number of 66.7 (corresponding to AMC III “fair” conditions). The 100-year, 6-hour storm estimate of 2.79 inches has a peak runoff of 320 cfs. However, when routed through the reservoir, the peak runoff is attenuated to a maximum flow of 130 cfs through the spillway.

Dam Break Analysis

The dam break scenario table in Appendix C tabulates the results of various reservoir elevations and the corresponding dam break maximum flow.

A 15-foot-wide breach was used with a 300 minute time-to-breach, corresponding to half of the inflow hydrograph. A sunny day break of East Timothy Lake Dam with the outlet channel at elevation 11,012.5 produces a maximum flow of 379 cubic feet per second (cfs) and maximum water depth in the downstream channel equal to 3.8 feet. By the time the breach flow reaches the foot bridge at Swift Creek Campground the flows depths have attenuated to 2.5 feet. Stream cross-sections were determined by WMS from the DEM data.

Several Forest Service campgrounds are located downstream of the subject lakes, including Riverview Campground which is approximately 8.5 miles from East Timothy Lake and is estimated to be 0.5 to 2 feet above average river flows, depending on the time of year. Due to the proximity of the campground to the river, this campground is considered to be most at risk of damage/danger due to breach flow flooding.

Accepted stabilization design values for dams in Garfield basin performed in 2009 allowed breach flows up to 450 cubic feet per second from Five Point Lake. Anticipated maximum breach flows from East Timothy at Swift Creek Campground – two miles upstream of Riverview Campground - are 296 cubic feet per second. Based on the flows accepted from Five Point Lake it follows that flows from East Timothy Lake would be within acceptable limits.

Outlet Works

Leaving the outlet pipe in place and plugging the pipe with cement grout is the proposed alternative. The outlet pipe at East Timothy Lake is 230 feet in length. It would require about 16 CY of cement to seal completely with grout.

As shown on the drawings, the plugged outlet pipe will be protected on the downstream end with a grouted rock gabion basket cutoff wall and additional protection at the downstream end in the form of a filter material that will prevent migration of fines in the event that some water is able to flow through the grouted pipe. A collar with headgate and vent will be fabricated and fastened over the upstream cone-shaped end of the pipe. This will enable the pipe to be closed from the upstream side when ready to grout (currently, the only gate on the pipe is located in the middle of the dam, at the wet well).

The corrugated metal pipe (CMP) shaft from the top of East Timothy Lake Dam down into the outlet works will be utilized during the grouting project to access the upstream portion of the pipe and fill it with grout. The downstream portion of the pipe will also be filled with one continuous grout placement made from the downstream end utilizing a fitting that will be welded to the steel pipe for that purpose. The CMP shaft would then be cut off at least 3 feet below the ground surface. The remainder of the shaft will be filled with 12 CY of cement grout. A covering, no more than about 6 foot in depth, of locally available sand will be placed to fill the removed CMP void to become flush with the embankment surface.

Working in the confined spaces of the CMP access shaft will require ventilation and monitoring and other safety equipment in accordance with appropriate safety standards.

Breach Channel

The constructed breach channel will be located to the right side of the existing outlet pipe. The design drawings in Appendix B show the location of the channel. Based on the results of the dam break analysis and as shown on the drawings, the maximum recommended breach channel invert elevation is 11,012.5 feet. A grouted rock gabion basket cutoff wall will be constructed at the upstream end of the breach channel to insure a stabilized elevation. The top of gabion elevation will be 11,011.5. Additional grade control will be obtained by constructing additional grouted rock gabion cutoff walls buried in the breach channel. These will be constructed and built to withstand potential high flows without downcutting. The voids among the large rock will be filled with smaller rock and grout. A stilling pool with slots for fish passage will be constructed to transition the new channel slope into the existing downstream grade.

The recommended width at the invert is 15 feet. Keeping the breach channel a minimum width of 15 feet will help reduce plugging due to ice, snow, and debris. The breach channel will be armored with a 36-inch layer of 18” D_{50} riprap along the invert and for a vertical height of 5 feet on the side slopes. The remainder of the outlet channel side slopes will not be armored; rock will be scattered to create a natural appearance.

A slope stability analysis was performed on the side slopes of the breach channel. Based on the assumptions discussed above under Deer Lake, the recommended slope configuration for the outlet channel is 2.5 horizontal to 1 vertical.

Because the main criteria for sizing the breach channel width is to prevent snow, ice and debris from building up and blocking or plugging the channel, the recommended width of the channel is much greater than necessary to pass normal outlet channel outflows. Therefore, a low flow channel that will generally contain all outflows is incorporated into the design.

In order to prevent erosion at the toe of the breach channel slopes, in some cases this will require additional riprap armoring at the downstream end of the new breach channel and existing outlet works channel transition due to the drop required. Field crews will take care to minimize this drop by lengthening the downstream transition as much as possible.

The Storm Spillway Hydraulics table in Appendix C provides 100 year storm hydraulic data for the outlet channel flows for East Timothy Lake dam.

Enlargement of Channel to Connect the Two Sub Basins

As previously discussed, the stabilization of the dam at elevation 11,012.5 will match the water surface elevations of the two adjacent sub basins that form(ed) the East Timothy Reservoir. The dam break analysis was calculated assuming that the channel connecting the two basins would be enlarged to a depth of 1.5 feet, and a width of 20 feet. This will allow some interchange of water flow, and fish movement, between the two sub basins within the stabilized lake.

Appendix A – Memorandum of Understanding

MEMORANDUM OF UNDERSTANDING

Intermountain Region
Forest Service
U. S. Department of Agriculture

Division of Water Rights
Department of Natural Resources
State of Utah

THIS MEMORANDUM OF UNDERSTANDING is entered into by the Division of Water Rights, Department of Natural Resources, State of Utah, hereafter called the Division, and the Intermountain Region, Forest Service, Department of Agriculture, hereafter referred to as the Forest Service.

WHEREAS, the Forest Service and the Division have certain responsibilities for the safety of dams by virtue of land status or public safety, and

WHEREAS, the Division has been created under Utah Statutes 73-5-5, 6, 7, 12, and 13, to provide public safety and resource protection by supervision and administration of a system to safeguard dams in the State of Utah, and

WHEREAS, the Forest Service under Acts of June 4, 1897 (16 U.S.C. 551), February 1, 1905 (16 U.S.C. 473), July 22, 1937 (16 U.S.C. 1010), June 12, 1960 (16 U.S.C. 528), as amended, is directed to regulate the occupancy and use of the National Forests and National Grasslands, and

WHEREAS, the Forest Service under administrative Manual requirements is directed to supervise and administer a system of inspections to safeguard dams located on National Forest lands, and

WHEREAS, the Forest Service and the Division mutually desire:

1. To periodically inspect dams located on National Forest lands.

2. To develop and document procedural methods to minimize duplication of effort and facilitate complementary inspections of dams.

NOW THEREFORE, the parties agree as follows:

1. The Forest Service agrees:

   a. To coordinate with the Division at the local and state levels in developing an annual inspection schedule for dams.

   b. To provide the Division copies of dam inspection reports made by Forest Service engineers.

c. To notify the Division of suspected safety hazards of dams located on National Forest lands.

2. The Division agrees:

a. To provide notification to the appropriate Forest Supervisor of the dams scheduled for Division inspection each calendar year.

b. To provide the Forest Service copies of dam inspection reports made by Division engineers.

c. To notify the Forest Service of suspected safety hazards of dams located on, or affecting, National Forest lands.

3. It is mutually agreed:

a. To cooperate in the periodic inspection of dams located on National Forest lands in the State of Utah.

b. To develop and seek application of safety measures required to protect public safety and resources.

c. That nothing herein shall be construed in any way as limiting the authority of the Division in carrying out its legal responsibilities for management or regulation of dam safety.

d. That nothing herein shall be construed as limiting or affecting in any way the legal authority of the Forest Service in connection with the proper administration and protection of National Forest System lands, in accordance with Federal laws and regulations.

e. That nothing in the Memorandum of Understanding shall be construed as obligating the Forest Service or the Division to expend funds in any contract or other obligation for future payment of funds or services in excess of those available or authorized for expenditure.

f. That amendments to this Memorandum of Understanding may be proposed by either party and shall become effective after written approval by both parties.

g. That this Memorandum of Understanding shall continue in force unless terminated by either party upon thirty (30) days notice in writing to the other of intention to terminate upon a date indicated.

h. Forest Service and local Division inspection personnel[1] will coordinate their annual inspection schedules to avoid duplication of effort.

[1] See Exhibit 1 attached hereto.

i. That agreements between Forest Supervisors and local dam inspection personnel of the Division can be made as amendments to this document if such agreements are deemed necessary.

j. That no member of or delegate to Congress, or Resident Commissioner of the United States shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom.

k. That each and every provision of this Memorandum is subject to the laws of the State of Utah, the laws of the United States, the regulations of the Secretary of Agriculture, and the regulations of the Division.

IN WITNESS THEREOF, the parties hereto have caused this Memorandum of Understanding to be executed as of the last date signed below.

Jeff M. Sirmon
JEFF M. SIRMON
Acting Regional Forester
Intermountain Region
USDA Forest Service

Date 4/4/80

Dee C. Hansen
DEE C. HANSEN
State Engineer
Division of Water Rights
Department of Natural Resources
State of Utah

Date April 14, 1980

This Memorandum of Understanding is applicable to the following National Forests:

Ashley National Forest
437 East Main
Vernal, Utah 84078

Dixie National Forest
Federal Building
82 North 100 East
P.O. Box 580
Cedar City, Utah 84720

Fishlake National Forest
P.O. Box 628
170 North Main Street
Richfield, Utah 84701

Manti-LaSal National Forest
350 East Main Street
Price, Utah 84501

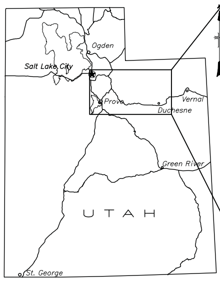
Uinta National Forest
P.O. Box 1428
88 West 100 North
Provo, Utah 84601

Wasatch National Forest
8226 Federal Building
125 South State Street
Salt Lake City, Utah 84138

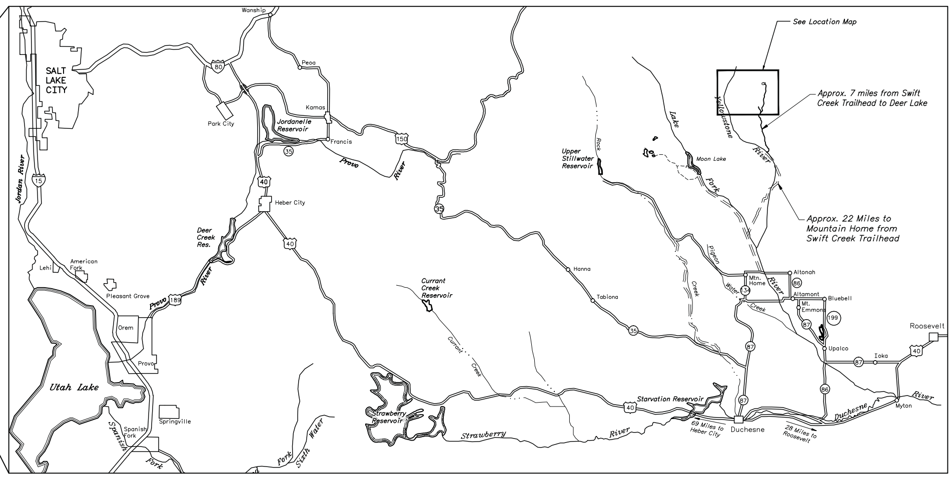
Appendix B – Drawings

OA58-418-99

RECLAMATION
Managing Water in the West



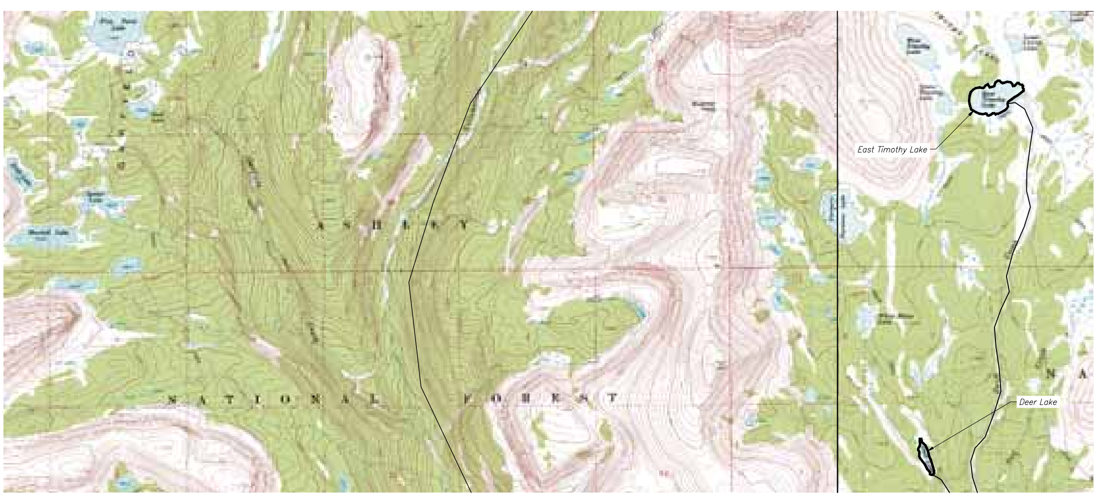
KEY MAP



N

VICINITY MAP

8 0 8 12 16
SCALE OF MILES



LOCATION MAP
NOT TO SCALE

Sequence no.	Drawing no.	Title
1	OA58-418-99	Key Map, Vicinity Map, Location Map and Drawing List
2	OA58-418-100	Deer Lake Plan and Profile
3	OA58-418-101	Deer Lake Sections, Detail and Tables
4	OA58-418-102	East Timothy Lake Overall Plan
5	OA58-418-103	East Timothy Lake Breach Plan and Profile
6	OA58-418-104	East Timothy Lake Breach Sections, Detail and Tables
7	OA58-418-105	East Timothy Lake Existing Outlet Profile

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PROVO AREA OFFICE
PROVO, UTAH

SWIFT CREEK BASIN LAKES

EAST TIMOTHY AND DEER LAKES

VICINITY AND LOCATION MAPS

DESIGNED MICHAEL DRAPER CHECKED /S/ SCOTT WINTERTON

DRAWN MICHAEL DRAPER TECH. APPR. /S/ CARY SOUTHWORTH, P.E.
CARY SOUTHWORTH, P.E.

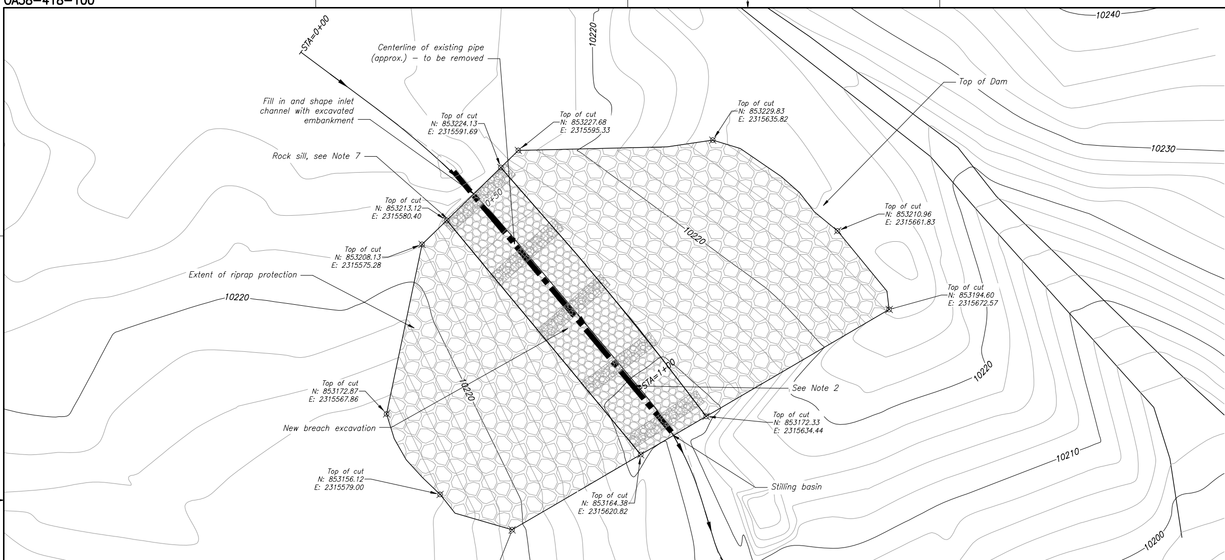
APPROVED DAVID YATES, P.E.
DAVID YATES, P.E. – PEER REVIEWER

PROVO, UTAH 2010-01-14
SHEET 1 OF 1

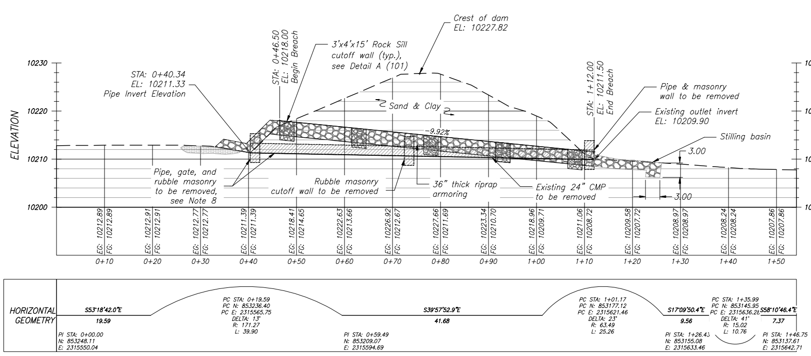
OA58-418-99

OA58-418-100

RECLAMATION
Managing Water in the West



PLAN



PROFILE

NOTES

1. Contour interval is 2 feet.
2. Vary centerline alignment along breach to create resting pools.
3. Breach El. 10,218. Cut vol. = 1390 c.y.
4. Mix sand filter material into riprap for 5 feet every 15 feet through breach.
5. Contours shown through the breach represent excavated grade below final riprap placement.
6. Grid factor = 0.99949466
7. Rock sill shall be 24"–36" riprap intermixed with smaller rock to lock riprap together.
8. Compact backfill to the extent possible based on tools allowed to be used. Backfill material shall be a matrix of 6"–12" rock mixed with fine soil.

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PROVO AREA OFFICE
PROVO, UTAH

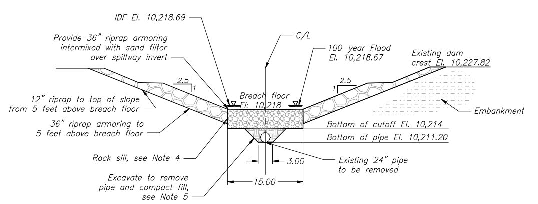
SWIFT CREEK BASIN LAKES
DAM STABILIZATION

DEER LAKE
PLAN AND PROFILE

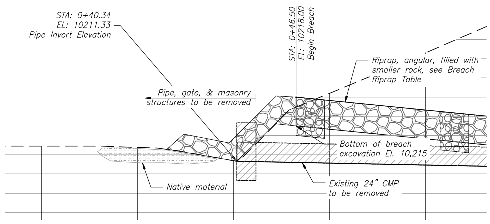
DESIGNED ____ CHECKED ____
DRAWN ____ TECH. APPR. ____
APPROVED ____
PEER REVIEWER

PROVO, UTAH SHEET 1 OF 1 2010-01-14 OA58-418-100

RECLAMATION
Managing Water in the West

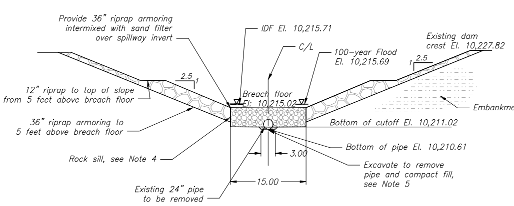


BREACH CHANNEL SECTION AT STA. 0+46.50

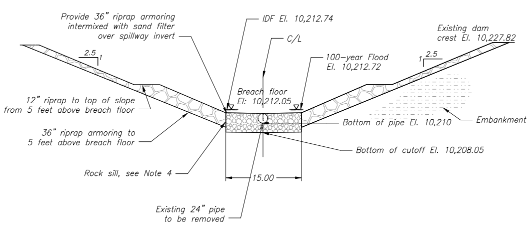


DETAIL A

SCALE OF FEET (5 0 5 10 15)



BREACH CHANNEL SECTION AT STA. 0+76.50



BREACH CHANNEL SECTION AT STA. 1+06.50

SCALE OF FEET (10 0 10 20 30)

ROCK SILL ELEVATIONS

STATION	BREACH FLOOR	TOP OF ROCK SILL	BOTTOM OF ROCK SILL	100 YEAR FLOOD ELEVATION	IDF ELEVATION
0+46.50	10,218.0	10,218.0	10,214.0	10,218.67	10,218.69
0+61.50	10,216.51	10,216.51	10,212.51	10,217.18	10,217.20
0+76.5	10,215.02	10,215.02	10,211.02	10,215.69	10,215.71
0+91.50	10,213.54	10,213.54	10,209.54	10,214.21	10,214.23
1+06.50	10,212.05	10,212.05	10,208.05	10,212.72	10,212.74

BREACH RIPRAP

D MIN.	D15	D50	D MAX.	THICKNESS MIN.
9"	12"	18"	27"	36"

SAND FILTER MATERIAL GRADATION REQUIREMENTS

SIEVE SIZE	% PASSING BY WEIGHT
1/2 inch	100
3/8 inch	100
No. 4	95–100
No. 8	80–100
No. 16	50–85
No. 30	25–60
No. 50	10–30
No. 100	2–10
No. 200	0–3

NOTES

1. Flood elevations through the breach represent elevations as if the existing spillway does not operate.
2. Place riprap through breach in layers to maintain correct gradations.
3. Bedrock elevations are unknown. Adjustments will be required in the field to determine riprap requirements. Where bedrock is encountered, a min. 12" thick riprap layer shall be required prior to transition to bedrock.
4. Rock sill shall be 24"–36"ø riprap intermixed with smaller rock to lock riprap together.
5. Compact backfill to the extent possible based on tools allowed to be used. Backfill material shall be a matrix of 6"–12" rock mixed with fine soil.

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PROVO AREA OFFICE
PROVO, UTAH

SWIFT CREEK BASIN LAKES
DAM STABILIZATION

DEER LAKE
SECTIONS, DETAIL AND TABLES

DESIGNED ____ CHECKED ____
DRAWN ____ TECH. APPR. ____
APPROVED ____ PEER REVIEWER

PROVO, UT 2010-01-14 SHEET 1 OF 1 **OA58-418-101**

RECLAMATION
Managing Water in the West

OVERALL PLAN

100 0 100 200 300
SCALE OF FEET

NOTES

1. Contour interval is 2 feet.
2. Vary centerline alignment along breach to create resting pools.
3. Breach El. 11,012.50. Cut vol. = 8,400 c.y.
4. Contours shown through the breach represent excavated grade below final riprap placement.
5. Grid factor = 0.99949466.
6. Strip riprap above El. 11,015.00 along upstream face of dam for placement in breach.
7. Lake connection shall be 20 feet wide at El. 11,011.00 with 3:1 side slopes.
8. Bury existing drain wells under waste pile.

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BUREAU OF RECLAMATION
PROVO AREA OFFICE
PROVO, UTAH

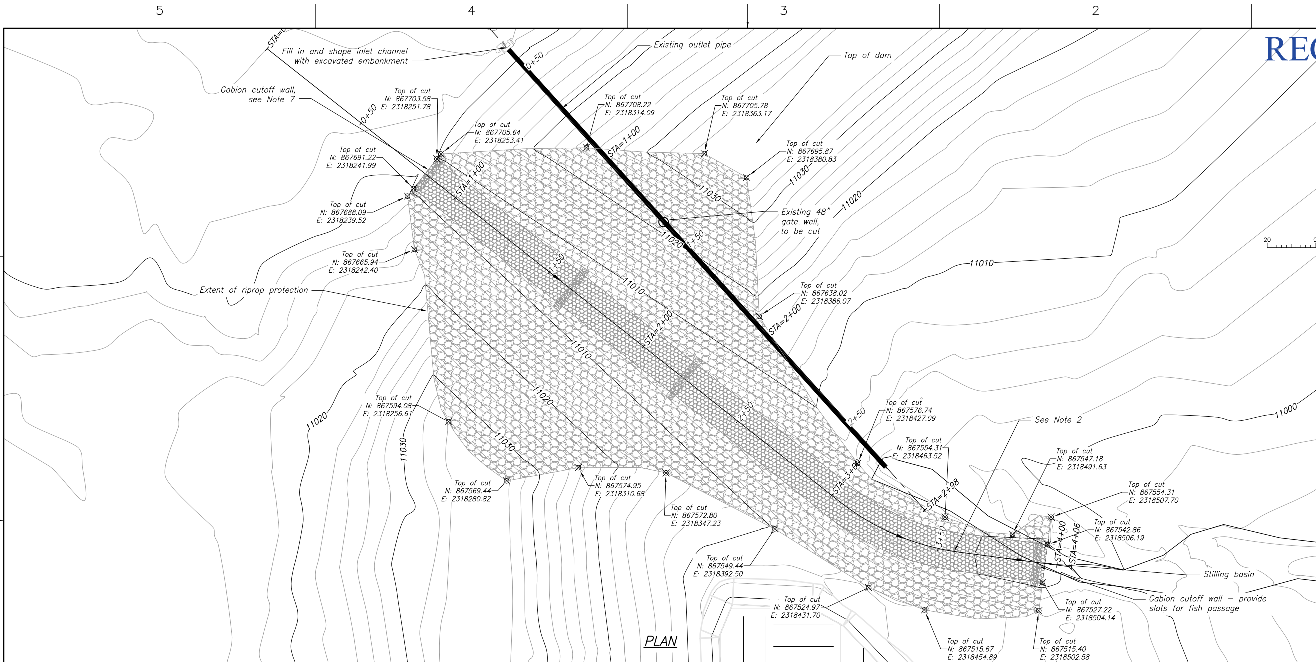
SWIFT CREEK BASIN LAKES
DAM STABILIZATION

EAST TIMOTHY LAKE
OVERALL PLAN

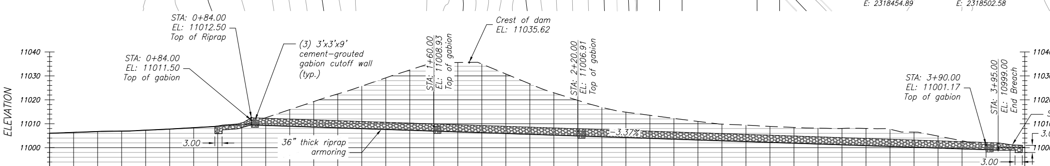
DESIGNED ____ CHECKED ____
DRAWN ____ TECH. APPR. ____
APPROVED ____
PEER REVIEWER

PROVO, UTAH 2010-01-14
SHEET 1 OF 1
0A58-418-102

RECLAMATION
Managing Water in the West



PLAN



Station	EG	FG
0+10	11006.37	11006.37
0+20	11006.73	11006.73
0+30	11006.91	11006.91
0+40	11007.29	11007.28
0+50	11007.76	11007.76
0+60	11008.34	11008.34
0+70	11008.91	11008.91
0+80	11009.60	11009.60
0+90	11012.51	11009.29
1+00	11015.88	11008.96
1+10	11019.25	11008.62
1+20	11022.45	11008.28
1+30	11025.70	11007.95
1+40	11029.16	11007.61
1+50	11032.43	11007.27
1+60	11035.38	11006.93
1+70	11035.56	11006.60
1+80	11034.95	11006.26
1+90	11030.80	11005.92
2+00	11026.64	11005.58
2+10	11022.92	11005.25
2+20	11019.75	11004.91
2+30	11016.80	11004.57
2+40	11014.83	11004.23
2+50	11013.52	11003.90
2+60	11012.23	11003.56
2+70	11010.96	11003.22
2+80	11009.83	11002.88
2+90	11009.40	11002.55
3+00	11008.87	11002.21
3+10	11008.44	11001.87
3+20	11008.15	11001.53
3+30	11008.04	11001.20
3+40	11008.02	11000.86
3+50	11007.69	11000.52
3+60	11006.48	11000.18
3+70	11004.83	10999.85
3+80	11002.87	10999.51
3+90	11001.22	10999.17
4+00	11000.13	11000.13

HORIZONTAL GEOMETRY

PI STA: 0+00.00
N: 867749.51
E: 2318181.01

S51°39'17.5"E
303.96

PC STA: 3+03.96
PC N: 867560.94
PC E: 2318419.40
DELTA: 31°
R: 102.40
L: 55.14

S82°30'24.0"E
47.01

PI STA: 3+59.10
N: 867539.72
E: 2318469.57

PROFILE

NOTES

1. Contour interval is 2 feet.
2. Vary centerline alignment along breach to create resting pools.
3. Breach El. 11,012.50. Cut vol. = 8,400 c.y.
4. Contours shown through the breach represent excavated grade below final riprap placement.
5. Grid factor = 0.99949466

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PROVO AREA OFFICE
PROVO, UTAH

SWIFT CREEK BASIN LAKES
DAM STABLILIZATION

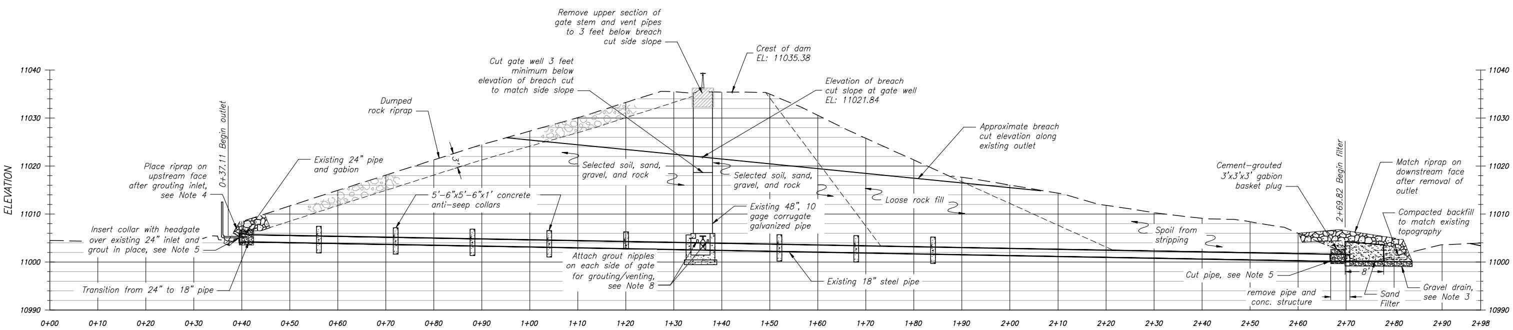
EAST TIMOTHY LAKE BREACH
PLAN AND PROFILE

DESIGNED ______ CHECKED ______
DRAWN ______ TECH. APPR. ______
APPROVED ______
PEER REVIEWER

PROVO, UTAH 2010-01-14
SHEET 1 OF 1

0A58-418-103

RECLAMATION
Managing Water in the West



EXISTING OUTLET PROFILE

10 0 10 20 30
SCALE OF FEET

NOTES

1. Provide compacted filter material over last 8' of pipe removal trench.
2. Trench walls shall be sloped to allow adequate compaction between fill and natural ground. Actual slope will depend on compaction method used.
3. Extend gravel drain through compacted sloped material to discharge under riprap.
4. Fill inlet area around vent pipe with embankment material compacted to the extent possible. Snap off vent pipe after completion of work.
5. Method of installing collar and headgate shall be determined in the field.
6. Do not remove outlet anti-seep collars.
7. Confined space requirements shall be met for access through gate well with air monitoring and supplied fresh air.
8. Grout shall be pumped upstream in nipple upstream of gate. Nipple downstream of gate shall be used for venting for grout pumped from the downstream outlet.

SAND FILTER MATERIAL GRADATION REQUIREMENTS

SIEVE SIZE	% PASSING BY WEIGHT
$\frac{1}{2}$ inch	100
$\frac{3}{8}$ inch	100
No. 4	95–100
No. 8	80–100
No. 16	50–85
No. 30	25–60
No. 50	10–30
No. 100	2–10
No. 200	0–3

GRAVEL DRAIN MATERIAL GRADATION REQUIREMENTS

SIZE	% PASSING BY WEIGHT
1 $\frac{1}{2}$ inch	90–100
$\frac{3}{4}$ inch	55–100
$\frac{3}{8}$ inch	19–75
No. 4	0–40
No. 8	0–10
No. 16	0

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PROVO AREA OFFICE
PROVO, UTAH

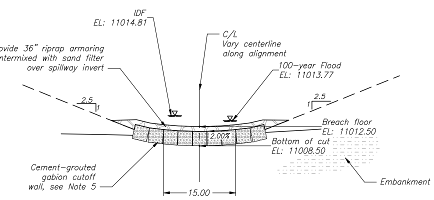
SWIFT CREEK BASIN LAKES
DAM STABILIZATION

EAST TIMOTHY LAKE
EXISTING OUTLET PROFILE

DESIGNED ________ CHECKED ________
DRAWN ________ TECH. APPR. ________
APPROVED ________
PEER REVIEWER

PROVO, UTAH 2010-01-14
SHEET 1 OF 1
0A54-418-105

RECLAMATION
Managing Water in the West



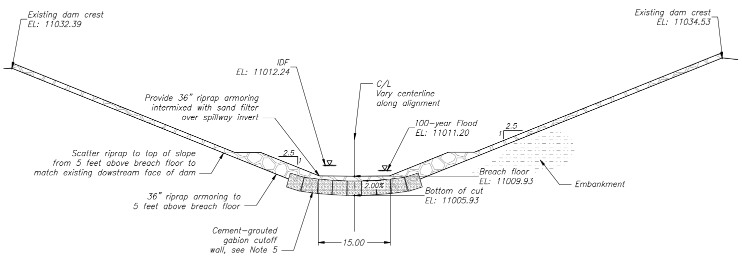
BREACH CHANNEL SECTION AT STA. 0+84

10 0 10 20 30
SCALE OF FEET

BREACH RIPRAP				
D MIN.	D15	D50	D MAX.	THICKNESS MIN.
9"	12"	18"	27"	36"

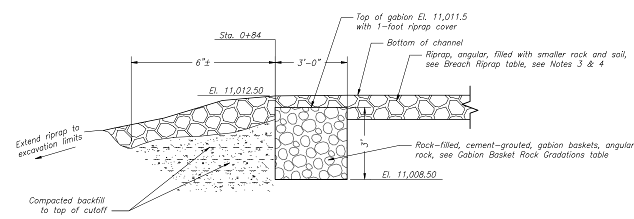
GABION CUTOFF WALL ELEVATIONS					
STATION	BREACH FLOOR	TOP OF GABION	BOTTOM OF GABION	IDF ELEVATION	100 YEAR FLOOD ELEVATION
0+84	11,012.5	11,011.50	11,008.50	11,014.81	11,013.77
1+60	11,009.93	11,008.93	11,005.93	11,012.24	11,011.20
2+20	11,007.91	11,006.91	11,003.91	11,010.22	11,009.18
3+90	11,002.17	11,001.17	10,998.17	11,004.48	11,003.44

GABION BASKET ROCK GRADATIONS			
GABION BASKET HEIGHT (INCHES)	PREDOMINATE ROCK SIZE (INCHES)	MINIMUM ROCK SIZE (INCHES)	MAXIMUM ROCK SIZE (INCHES)
36	6 to 10	4	12



BREACH CHANNEL SECTION AT STA. 1+60

10 0 10 20 30
SCALE OF FEET

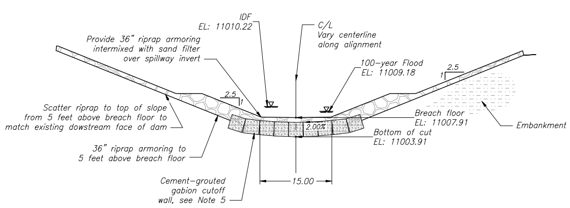


SECTION A-A
GABION BASKET WALL

2 0 2 4 6
SCALE OF FEET

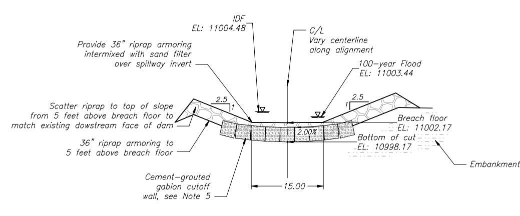
NOTES

1. Flood elevations through the breach represent elevations as if the existing spillway does not operate.
2. Place riprap through breach in layers to maintain correct gradations.
3. Bedrock elevations are unknown. Adjustments will be required in the field to determine riprap requirements. Where bedrock is encountered, a min. 12" thick riprap layer shall be required prior to transition to bedrock.
4. Compact backfill to the extent possible based on tools allowed to be used.
5. Gabion baskets shall be rock-filled, cement-grouted, angular rock. See Gabion Basket Rock Gradations table.
6. Compact backfill to the extend possible based on tools allowed to be used.



BREACH CHANNEL SECTION AT STA. 2+20

10 0 10 20 30
SCALE OF FEET



BREACH CHANNEL SECTION AT STA. 3+90

10 0 10 20 30
SCALE OF FEET

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PROVO AREA OFFICE
PROVO, UTAH

SWIFT CREEK BASIN LAKES
DAM STABILIZATION

EAST TIMOTHY LAKE BREACH
SECTIONS, DETAIL AND TABLES

DESIGNED _______ CHECKED _______
DRAWN _______ TECH. APPR. _______
APPROVED _______
PEER REVIEWER

PROVO, UTAH 2010-01-14
SHEET 1 OF 1

0A58-418-104

Appendix C - Inflow Hydrology Output

Table C.1 - Dam Break Analysis Summary

	Spillway Floor Elev. (ft)	Bottom of Breach Elev. (ft)	Time to Breach (min.)	Dam Break Max. Flow (cfs)	Max. Depth in Channel (ft.)	Max. Depth @ Swift Creek CG (ft.)
Deer	10,218.0	10,213.0	300	78	2.2	1.5
East Timothy	11,012.5	11,003.5	300	379	3.8	2.5

Table C.2 - 100 yr. Storm Spillway Hydraulics

	AMC III Composite CN	Routed Flow in Spillway (cfs)**	Depth in Spillway (ft.)	Velocity in Spillway (ft.)
Deer	66.0	73	0.86	5.0
East Timothy	66.7	130	1.63	4.2

* *100-year, 6-hour, SCS Type II event routed through the reservoir

Appendix D – Construction Quantities

Construction quantities are approximate

Lake	Outlet channel Width (1)	Outlet channel Elevation	Outlet channel Excavation (cy)	Outlet Grout Backfill (cy)	Gabion Basket Grout (cy)	Riprap removed from Dam Volume (cy)	Inlet/Outlet Channel Fill (cy)	Riprap Placed In Breach (cy)	Riprap Volume Stilling Pool Sill (cy)	Filter Material (cy)
Deer	15'	10,218.0	1,350	0	0	200	0	450	15	5
East Timothy (2)	15'	11,012.5	8,400	28 (3)	22	600	180	2,000	15	5

Lake	Total Bulk Amount of Material Handled (4)
Deer	2,020 CY
East Timothy	11,325 CY

(1) 2.5:1 sideslopes, both sides, finished width

(2) Potential volume for excavated embankment along downstream toe = 9000 cy. Also, additional excavation for lake connection at elevation 11,011.0 = 125 cy

(3) Includes grout (12 cy) for gate well in center of dam.

(4) The sum of 'Outlet Channel Excavation' + 'Riprap Removed from Dam' + 'Riprap Placed in Breach' + 'Riprap Volume, Sill' + 'Inlet/Outlet Channel Fill' + 'Filter Material' + 'E.T. excavated lake connection'

Appendix E – Dam Break Results

Table E.1 - WMS Breach flows for Deer Dam

Breach Elevation	Max Breach Flows at Dam	Max Breach Flows at Swift Creek Campground
10212	1	1
10213	3	3
10214	7	7
10215	12	12
10216 (natural)	18	18
10217	36	36
10218 (hand Level)	78	77
10219	127	126

Notes:

1. Bottom of Breach: 10213
2. Time of Breach: 300 min
3. Breach Width: 15 ft
4. Breach Flows in CFS

Table E.2 - WMS Breach flows for East Timothy Dam

Breach Elevation	Max Breach Flows at Dam	Max Breach Flows at Swift Creek Campground
11008	1	1
11009	6	6
11010	12	12
11011	17	17
11012	343	225
11012.5*	379	277
11012.5**	379	296
11013	404	319
11014	488	420
11015	588	518

Notes:

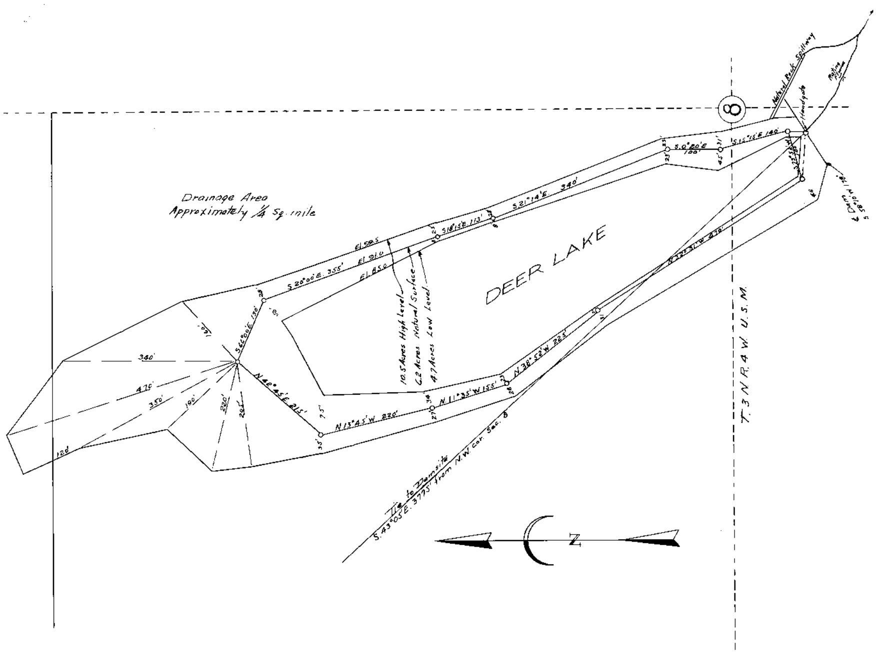
1. Bottom of Breach: 11003.5
2. Time of Breach: 300 min
3. Breach Width: 15 ft
4. Breach Flows in CFS

* Stabilized breach elevation without deepening channel between each reservoir section

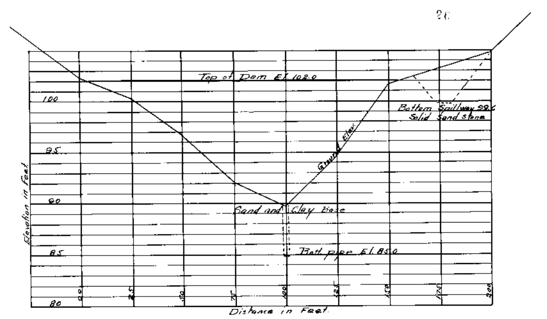
** Stabilized breach elevation after deepening channel between each reservoir section

Appendix F – Historical Drawings

of 2
Sheet ONE SHEETS



MAP
Scale 1 in = 100 ft.



PROFILE
of
DAM

ENGINEER'S CERTIFICATE

C. J. Preece being first duly sworn, certifies that he was employed to prepare the plans and specifications for the dam proposed to be constructed in connection with the appropriation of water under application 9628, that these plans consisting of ~~one~~ two sheets indicate the information to be submitted for approval of said plans and the survey of the site was made by him on the 14th day of Aug. 1928.

C. J. Preece

Subscribed and sworn to before me this 21 day of July 1924

Mabel Turner
Notary Public.
Com. exp. Mar 5, 1930
Bluebell Utah

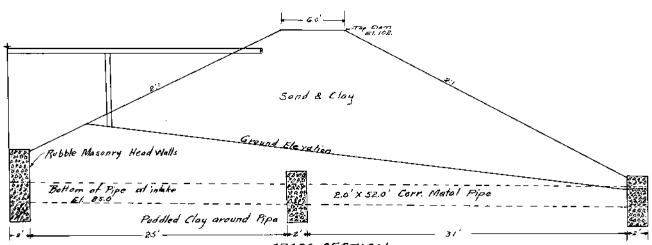
OWNER'S CERTIFICATE

M. E. Ward Jr. for Farmers Irrigation Company, being first duly sworn, certifies that he employed C. J. Preece, of Duchesne, Utah, to prepare the accompanying plans of dam to be constructed in connection with the appropriation of water under application 9628 and that he hereby accepts these plans.

M. E. Ward Jr.

Subscribed and sworn to before me this 26 day of July 1924.

Mabel Turner
Bluebell Ut Notary Public.
Com. expires Mar 5 1930



CROSS-SECTION
of
DAM
Scale 1" = 5.0'

MAP, DRAWINGS AND PROFILE OF DEER LAKE RESERVOIR IN DUCHESNE COUNTY BY FARMERS IRRIGATION COMPANY

Application 9628

Feb. 1929 Scales as shown

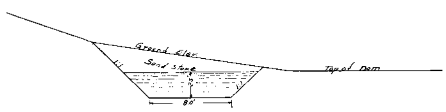
72

Received Feb. 6, 1929
Returned April 13, 1929
Approved Jan. 8, 1931
Geo. M. Bacon

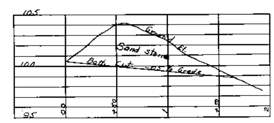
Deer Lake
P. 72

d. 1896

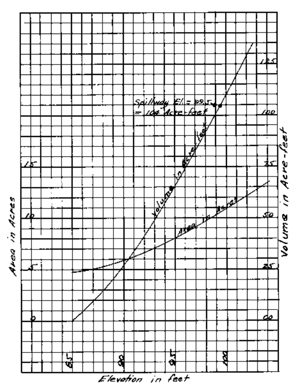
UT87



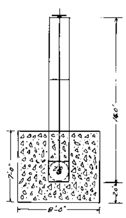
CROSS-SECTION
of
SPILLWAY
Scale 1"=5'



PROFILE
of
SPILLWAY



CAPACITY CURVE



Burnham Gate
with
Rubble Masonry
Head Wall

DEER LAKE
Application
9628

73

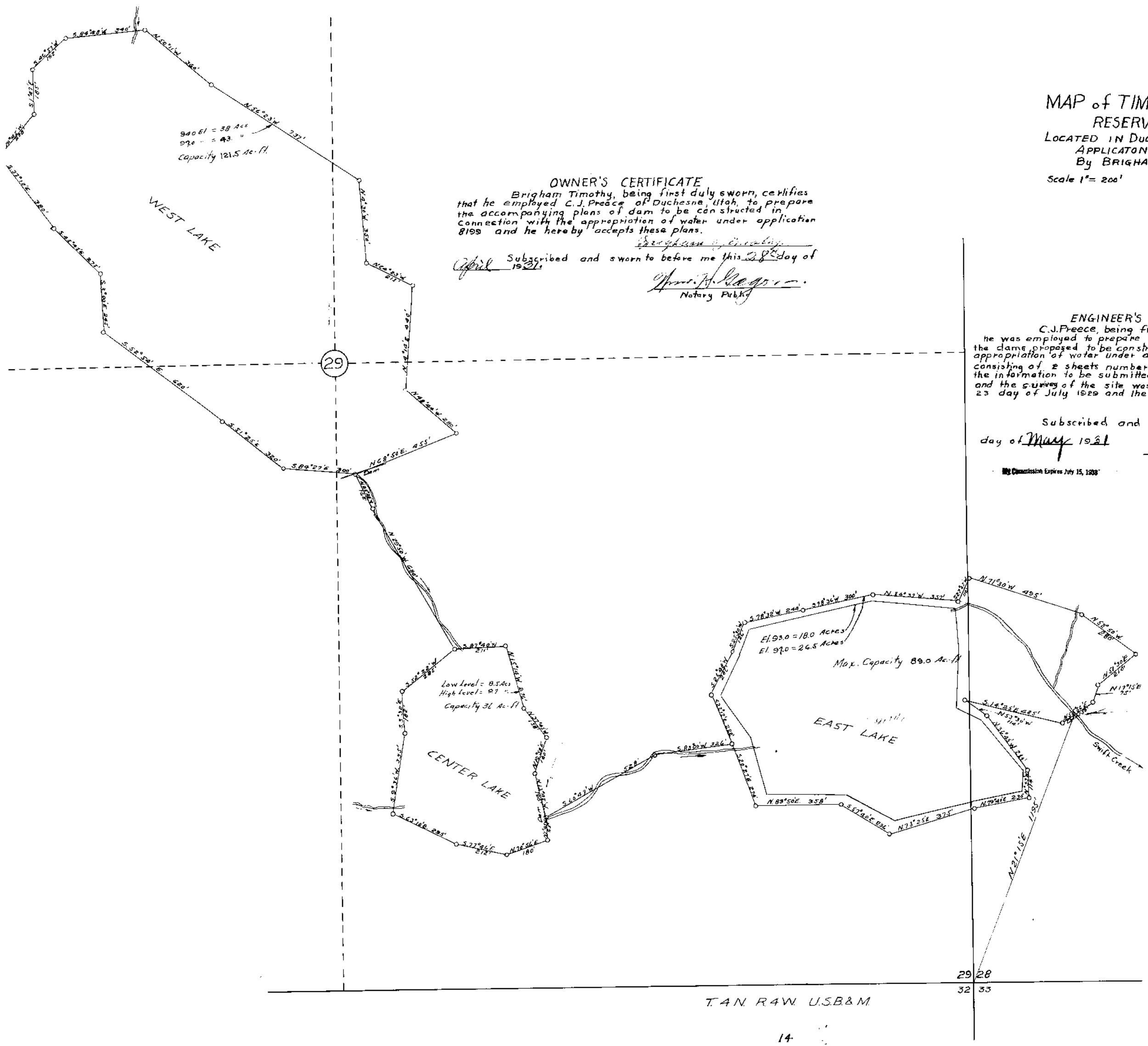
74
2
5

Deer Lake P-73

Sheet No 1 of 2 Sheets

MAP of TIMOTHY LAKES
RESERVOIR SITES
LOCATED IN DUCHESNE COUNTY
APPLICATON No 8199
By BRIGHAM TIMOTHY

Scale 1" = 200'   Surveyed July 1929



OWNER'S CERTIFICATE
Brigham Timothy, being first duly sworn, certifies that he employed C. J. Preece of Duchesne, Utah, to prepare the accompanying plans of dam to be constructed in connection with the appropriation of water under application 8199 and he hereby accepts these plans.

Brigham Timothy

Subscribed and sworn to before me this 28th day of April 1931.

Notary Public

ENGINEER'S CERTIFICATE
C. J. Preece, being first duly sworn, certifies that he was employed to prepare the plans and specifications for the dams proposed to be constructed in connection with the appropriation of water under application 8199; that these plans consisting of 2 sheets numbered 1 and 2 inclusive indicate the information to be submitted for approval of said plans, and the survey of the site was made by him between the 23 day of July 1929 and the 26 day of July 1929.

C. J. Preece

Subscribed and sworn to before me this 6 day of May 1931

Notary Public

My Commission Expires July 15, 1933

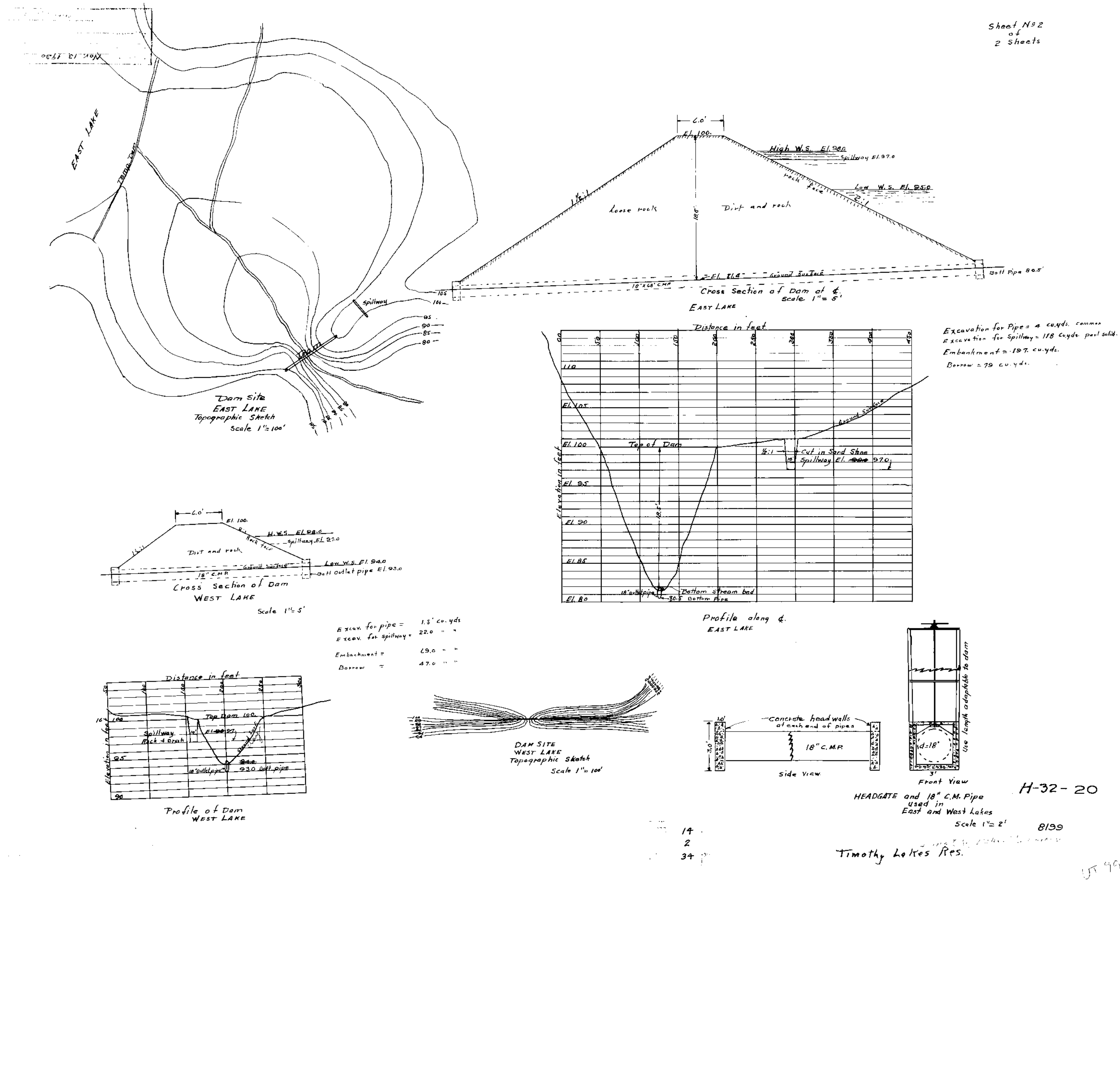
Nov. 13, 1930
Oct. 23, 1932
as per Letter Feb. 18, 1933
Geo. M. Bacon
State Engineer

8199 19

H-32

14
2
33

Timothy Lakes Res.


Sheet No 2
of
2 Sheets
Nov. 13 1930
EAST LAKE
Temp. Dam
Spillway
105
100
95
90
85
80
Dam Site
EAST LAKE
Topographic Sketch
Scale 1" = 100'
6.0'
El. 100.
High W.S. El. 98.0
Spillway El. 97.0
Rock face
Low W.S. El. 85.0
2:1
1½:1
Loose rock
Dirt and rock
18.6'
El. 81.4
Ground Surface
18" x 46' CMP
Outl Pipe 80.5'
Cross Section of Dam at ℄
Scale 1" = 5'
EAST LAKE
Distance in feet
Excavation for Pipe = 4 cu.yds. common
Excavation for Spillway = 118 cu.yds. part solid.
Embankment = 197. cu.yds.
Borrow = 79 cu.yds.
El. 110
El. 105
El. 100
El. 95
El. 90
El. 85
El. 80
Elevation in feet
Top of Dam
Ground Surface
½:1
Cut in Sand Stone
Spillway El. 97.0
18" outlet pipe
Bottom stream bed
80.5 Bottom Pipe
Profile along ℄
EAST LAKE
6.0'
El. 100.
H.W.S. El. 98.0
Spillway El. 97.0
Rock face
Dirt and rock
Ground Surface
Low W.S. El. 94.0
18" C.M.P.
Outl outlet pipe El. 93.0
Cross Section of Dam
WEST LAKE
Scale 1" = 5'
Excav. for pipe = 1.5 cu.yds
Excav. for spillway = 22.0 " "
Embankment = 69.0 " "
Borrow = 47.0 " "
Distance in feet
Elevation in feet
Top Dam 100.
Spillway
Rock & Brush
95
90
18" outlet pipe
93.0 outl pipe
Profile of Dam
WEST LAKE
DAM SITE
WEST LAKE
Topographic Sketch
Scale 1" = 100'
Concrete head walls
at each end of pipes
18" C.M.P.
Side View
d = 18"
Use length adaptable to dam
Front View
HEADGATE and 18" C.M. Pipe
used in
East and West Lakes
Scale 1" = 2'
H-32-20
8199
14
2
34
Timothy Lakes Res.

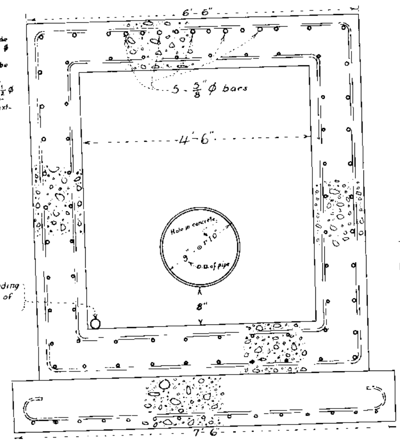
REINFORCEMENT STEEL

Inside curtain, center of which is 2½ in. from inside face of concrete all sides, top and bottom consisting of ½ ø bars spaced @ 8" centers, except transverse to ℄ of outlet pipe on ceiling downstream from manhole which bars are to be ⅝" ø.

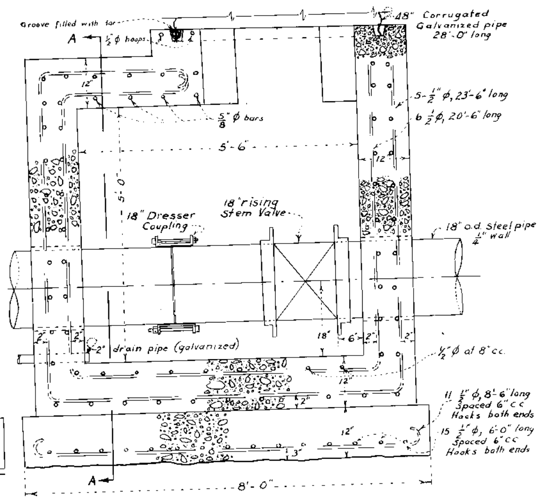
Outside curtain, center of which is 2½" from outside face of concrete, all sides, top and bottom consisting of ½ ø spaced @ 8" centers, with extra ⅝ ø bars in ceiling longitudinal to ℄ of outlet pipe, hooked on end with a L leg extending down the downstream end of box.

All laps shall be 40 diameters of bar. Hooks to be standard.

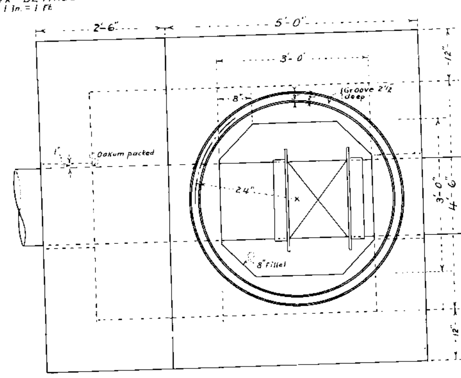
AREA-CAPACITY TABLE			
Contour	Area at Contour (Acres)	Volume Between Contours (Ac Ft)	Capacity Reservoir at Contour (Ac Ft)
68.5	0.0		
		0.3	
71	0.25		0.3
		8.5	
76	3.15		8.8
		11.0	
77	18.8		19.8
		65.2	
80	23.7		84.0
		139.0	
85	31.9		223.
		174.0	
90	37.6		397
		199.0	
95	42.0		596
		86.0	
97	44.3		682



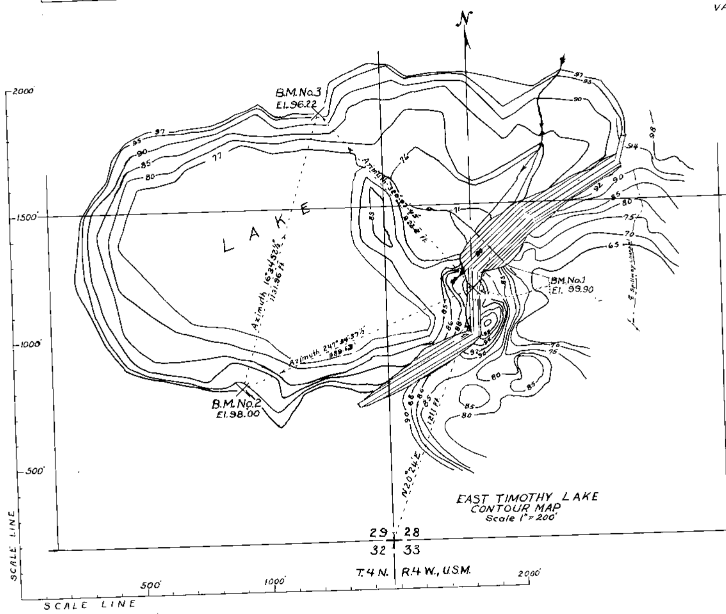
ELEVATION A-A



VALVE BOX DETAILS
Scale 1 In. = 1 Ft.



PLAN VIEW VALVE BOX

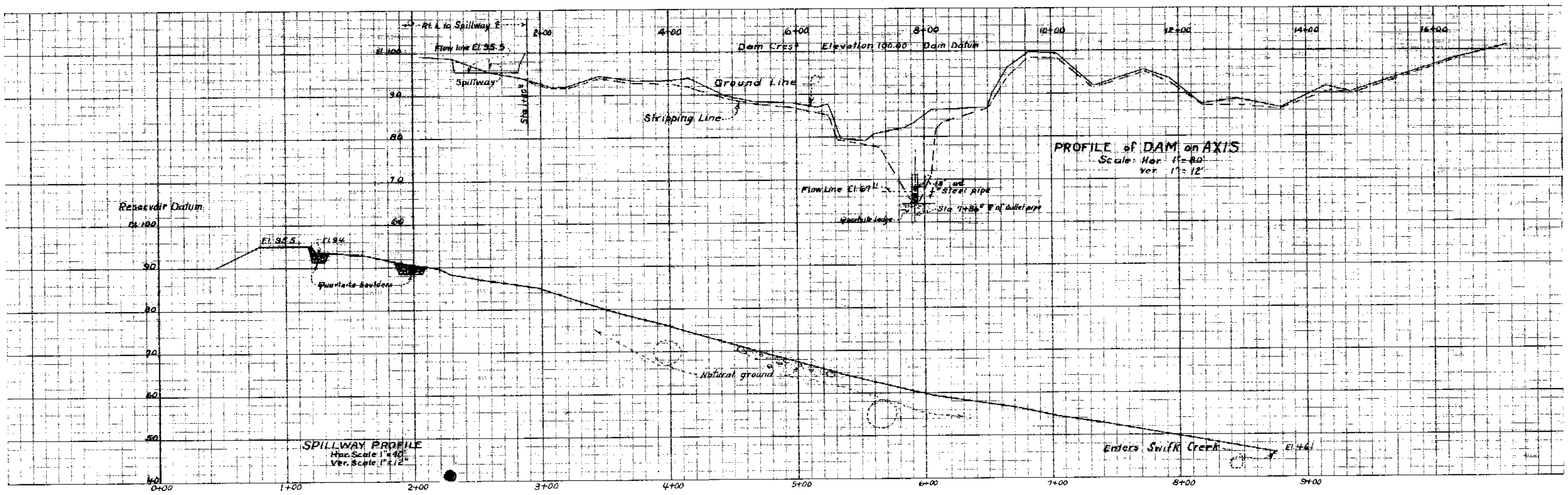


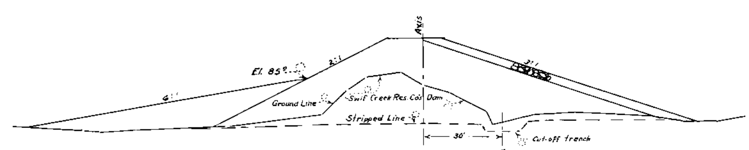
EAST TIMOTHY LAKE
CONTOUR MAP
Scale 1" = 200'

MOON LAKE WATER USERS' ASSN.
EAST TIMOTHY LAKE RESERVOIR
MAP and DRAWINGS
DUCHESNE COUNTY APPL. No. 13900
Scale: As shown AUG. 7, 1950
SHEET NO. 2 of 4

H-34-D
54

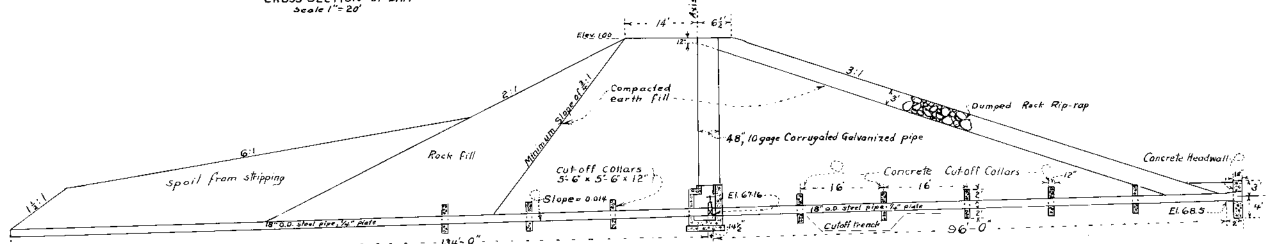
East Timothy Lake Res.





Sta 7+69.0

CROSS SECTION OF DAM
Scale 1" = 20'



Sta. 7+86.0 LONGITUDINAL SECTION AT OUTLET
Scale 1" = 10'

EAST TIMOTHY LAKE RESERVOIR
PROFILES and SECTIONS
DUCHESNE COUNTY APPL. No. 13900
Scales: As shown AUG. 7, 1950
SHEET NO. 3 of 4

H-34-D
55

East Timothy Lake Res. UT 91

OWNER'S CERTIFICATE

JOHN H. HASLEM, President of MOON LAKE WATER USERS' ASSN., being first duly sworn, certifies that he employed Louie Galloway of Roosevelt, Utah to prepare the accompanying plans for the dam to be constructed in connection with the appropriation of water under application No. 13900 and that he hereby accepts these plans.

John H. Haslem

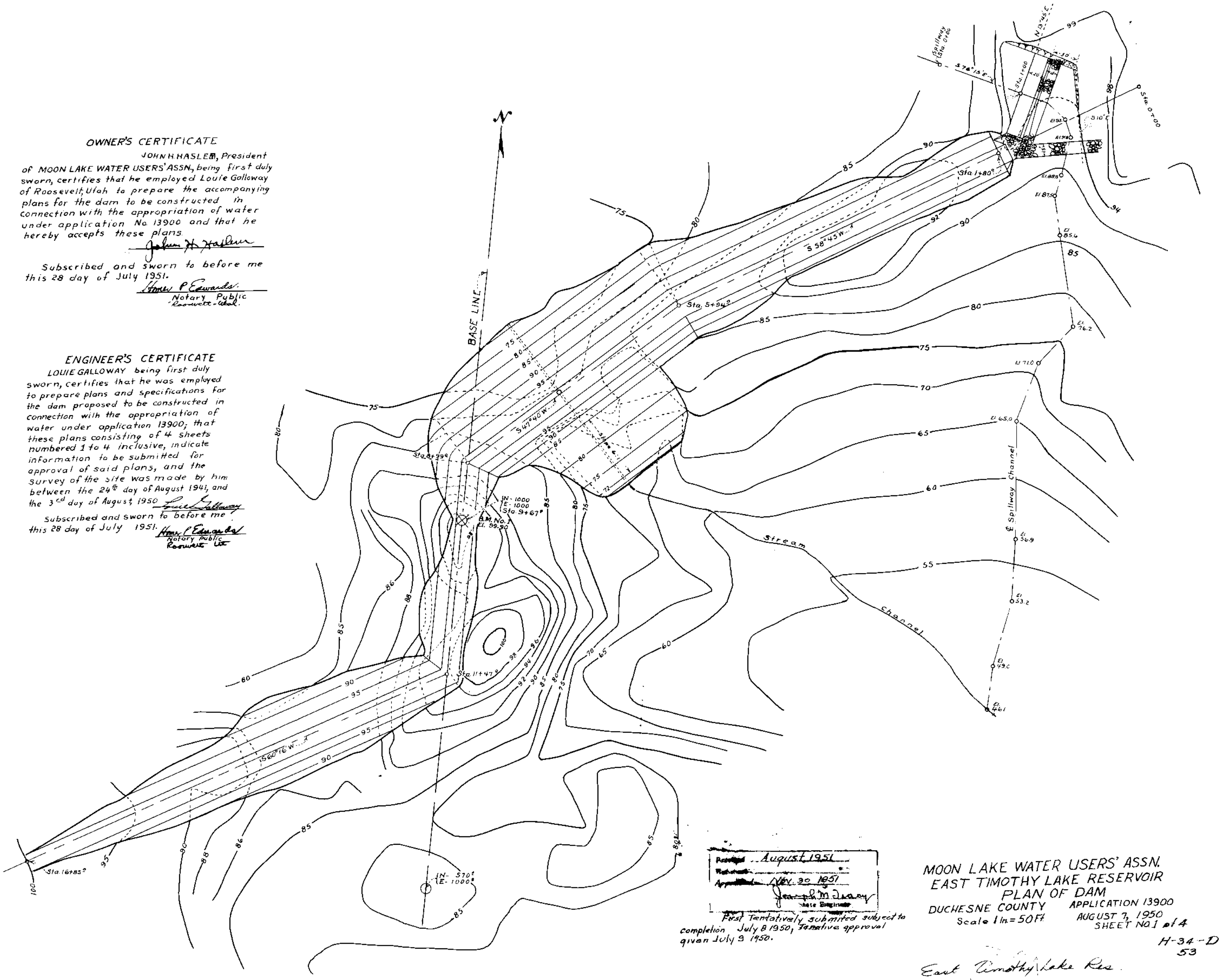
Subscribed and sworn to before me this 28 day of July 1951.

Homer P. Edwards
Notary Public
Roosevelt - Utah.

ENGINEER'S CERTIFICATE

LOUIE GALLOWAY being first duly sworn, certifies that he was employed to prepare plans and specifications for the dam proposed to be constructed in connection with the appropriation of water under application 13900; that these plans consisting of 4 sheets numbered 1 to 4 inclusive, indicate information to be submitted for approval of said plans, and the survey of the site was made by him between the 24th day of August 1941, and the 3rd day of August, 1950 Louie Galloway

Subscribed and sworn to before me this 28 day of July 1951. Homer P. Edwards
Notary Public
Roosevelt Ut.



Received August 1951
Returned
Approved Nov. 30 1951
Joseph M. Tracy
State Engineer

First Tentatively submitted subject to completion July 8 1950, Tenative approval given July 9 1950.

MOON LAKE WATER USERS' ASSN.
EAST TIMOTHY LAKE RESERVOIR
PLAN OF DAM

DUCHESNE COUNTY
Scale 1 In. = 50 Ft.

APPLICATION 13900
AUGUST 7, 1950
SHEET NO. 1 of 4

H-34-D
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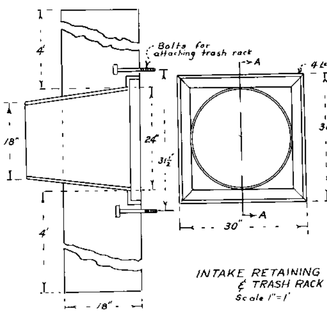
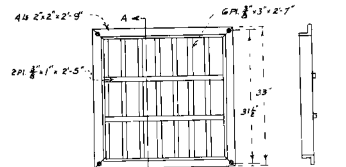
East Timothy Lake Res.

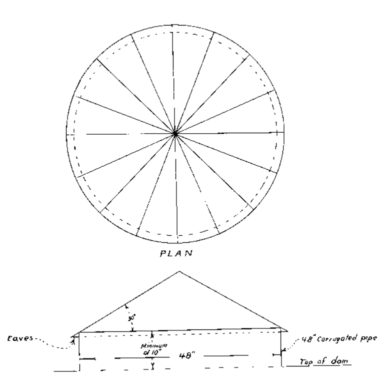


INTAKE RETAINING WALL
& TRASH RACK SEAT
Scale 1"=1'

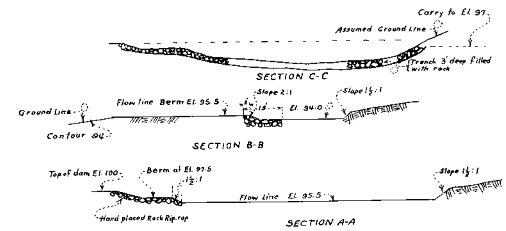
Section A-A



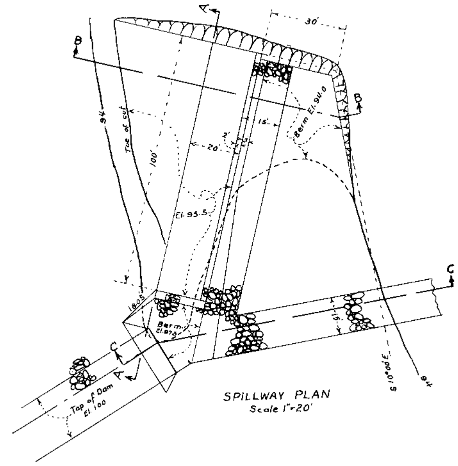
TRASH RACK
Scale 1"=1'



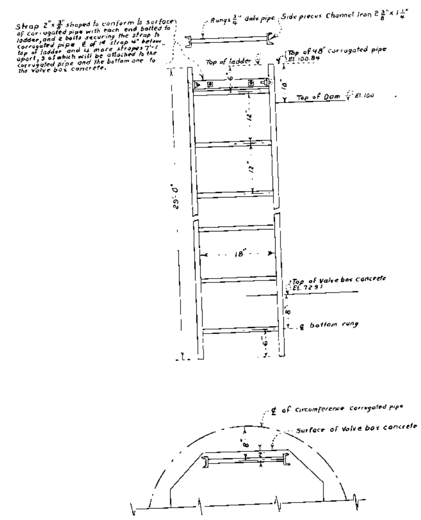
VALVE BOX WELL COVER
Design detail left to Manufacturer



SPILLWAY SECTIONS
Scale 1"=20'



SPILLWAY PLAN
Scale 1"=20'



VALVE BOX WELL LADDER Scale 1"=1 Ft

EAST TIMOTHY LAKE RESERVOIR
SPILLWAY DETAIL & DRAWINGS
SHEET No. 4 of 4

H-34-D
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East Timothy Lake Res

Appendix G – Slope Stability Analysis

Appendix G – Slope Stability Analysis

Figure G-1 shows the breach section of East Timothy. Color shading represents safety factors (FS) beginning with 1.5 and increasing incrementally in steps of 0.05 to a maximum of 2.25. Soil saturation is included 2 feet above breach invert. The white semi-circular line near the slope surface (hatched area) indicates the failure plane with a minimum static FS equal to 1.50, as calculated by the Morgenstern-Price method.

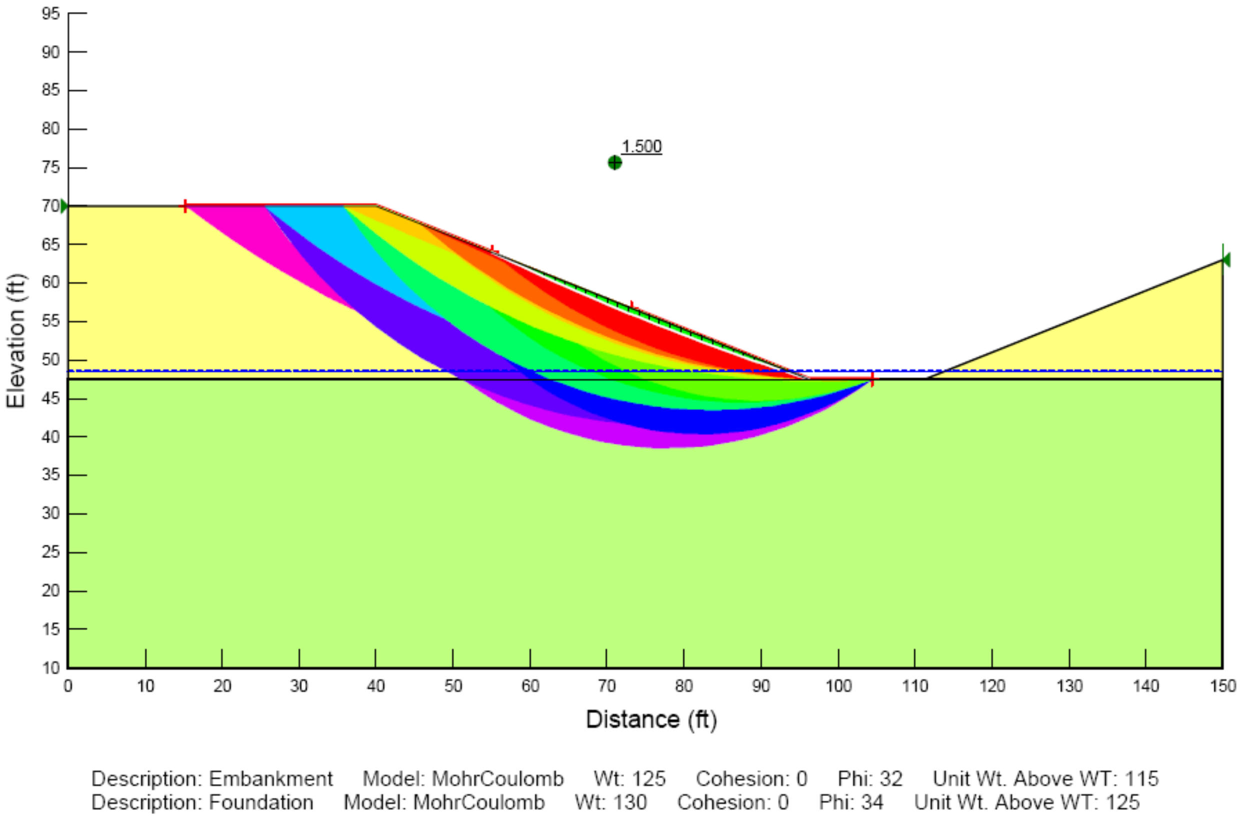

Figure G-1: East Timothy breach section and safety factor map, including the critical failure surface.

Bureau of Reclamation
Provo Area Office Materials Laboratory

Summary of Gradation and Hydrometer Analysis

RECLAMATION
Managing Water in the West

302 E. 1860 S.
Provo, Utah 84606
(801) 379-1000

Project: **High Mountain Lakes** **Feature:** **East Timothy Lake** **Description:** **samples from Test pits 1-6**

					Gradation -- Particle Size Fraction in Percent Passing											Hydrometer Analysis (min.)						
Sample	Top	Bottom	Date	Group	76.2	38.1	19.0	9.5	4.75	2.00	1.18	0.600	0.425	0.150	0.075	0.037	0.019	0.009	0.005	0.002	0.001	
No.	Depth	Depth	Classification	Sym.	3"	1 1/2"	3/4"	3/8"	#4	#10	#16	#30	#40	#100	#200	1	4	19	60	435	1545	DATE
Proc # 1 dam			Poorly graded sand with silt and gravel	(SP-SM)g	100	93.9	82.4	67.5	58.1	51.0	48.7	45.4	42.4	15.1	7.3	7.2	4.1	2.9	2.2			
Proc # 2 dam			Poorly graded sand with silt and gravel	(SP-SM)g	100	97.0	84.4	70.7	62.0	54.0	51.3	47.5	44.1	17.0	8.7	8.0	5.4	2.9	2.1			
Proc # 3 wells			Poorly graded sand with silt	(SP-SM)	100	96.3	85.6	85.5	85.5	72.7	69.8	65.7	62.1	22.8	9.0	7.6	4.8	3.5	3.5	2.1		
Proc # 4 wells			Poorly graded sand with silt and gravel	(SP-SM)g	100	94.9	80.0	63.0	53.6	42.8	40.7	37.8	35.3	12.0	4.2	3.2	1.6	0.5	0.5			
Proc # 5 borrow area			Silty sand with gravel	(SM)g	100	96.8	89.8	84.7	80.8	74.8	73.0	70.5	67.0	32.0	18.0	15.2	9.7	5.1	4.1			
Proc # 6 borrow area			Silty sand with gravel	(SM)g		100	95.4	89.2	85.1	79.8	77.8	75.0	72.2	37.2	22.4	18.2	14.0	8.9	7.2			

Bureau of Reclamation
Provo Area Office Materials Laboratory

Summary of Physical Properties

RECLAMATION
Managing Water in the West

302 E. 1860 S.
Provo, Utah 84606
(801) 379-1000

Project: High Mountain Lakes **Feature:** East Timothy Lake **Description:** samples from Test pits 1-6

Sample No.	Top Depth	Bottom Depth	Group Symbol	Fines Less Than .005 mm	Fines .005 to .075 mm	Sand .075 mm to #4	Gravel #4 to 3 in.	Cobble 3 in. to 5 in.	Cobble 5 in. to 12 in.	Boulder plus 12 in.	Atterberg Limits %LL	Atterberg Limits %PI	Atterberg Limits %SL	Specific Gravity Fraction (-) #4	Specific Gravity Fraction (+) #4	Specific Gravity (+) #4 % Abs.	In-place H20 Tot. %	In-place Dry Dens. (-) #4 %	In-place Dry Dens. pcf	Laboratory Max. Dry Dens. pcf	Laboratory Optimum Water Cont.
Proc # 1 dam			(SP-SM)g	2	5	51	42			100		NP			2.56	2.0	6.0	8.8			
Proc # 2 dam			(SP-SM)g	2	7	53	38			100		NP			2.56	1.7	7.1	10.5			
Proc # 3 wells			(SP-SM)	4	5	77	14			100		NP			2.58	2.0	6.1	6.7			
Proc # 4 wells			(SP-SM)g	1	3	50	46			100		NP			2.56	2.6	4.8	6.7			
Proc # 5 borrow area			(SM)g	4	14	63	19			100		NP			2.57	2.0	6.3	7.4			
Proc # 6 borrow area			(SM)g	7	15	63	15			100		NP			2.57	2.2	5.9	6.6			
0	0.0	0.0	0																		
0	0.0	0.0	0																		
0	0.0	0.0	0																		
0	0.0	0.0	0																		
0	0.0	0.0	0																		